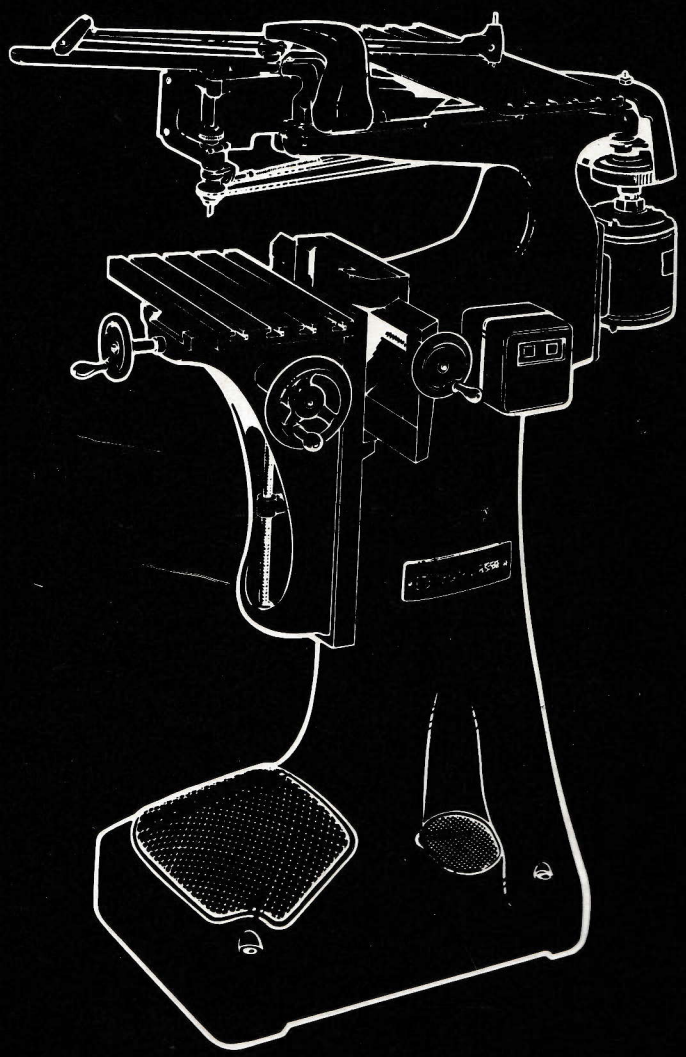
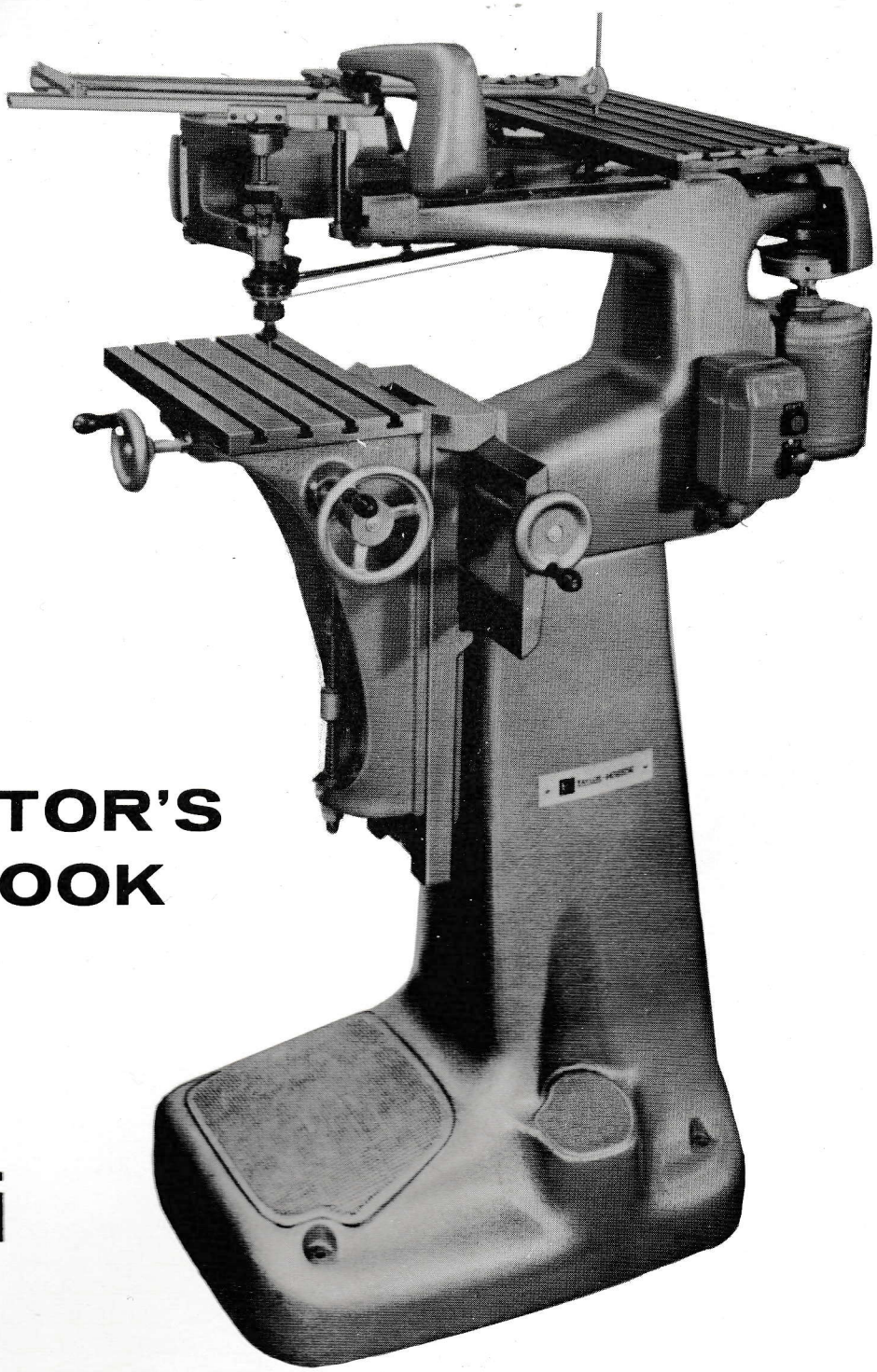
ENGRAVING MACHINE

OPERATOR'S HANDBOOK



MODEL D ENGRAVING MACHINE



OPERATOR'S HANDBOOK

TAYLOR-HOBSON

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SPECIFICATION

STANDARD EQUIPMENT PROVIDED WITH THE MACHINE

110/12 Table dogs and bolts (2)
110/15 Magnifying glass
110/19 Oilstone
110/120 Cutter wrench
110/121 0·3 inch/24 wrench
110/273 Grease gun
110/279R Motor belt (1 set)
110/313 12 inch rule (inches machine)
110/629 90°. style
110/895 Tyle 'L' collet spindle
110/830 Spindle drive belt (1 set)
110/908 Table fence (1½ inches [38 mm] long) (2)
116/37 Hex. wrench key $\frac{5}{32}$ inch A/F
116/41 $\frac{1}{4}$ inch UN/1 B.A. double-ended wrench
116/69 $\frac{1}{2}$ inch B.S. combination spanner
116/73 Hex. tubular wrench and tommy bar (0·3 inch/24 nut)
117/7 Tool box
17–7 Operator's handbook
Sample white filler

ADDITIONAL STANDARD EQUIPMENT

110/672 $\frac{1}{4}$ inch Collet } British
110/673 $\frac{3}{8}$ inch Collet } Machine
110/674 Adapter for taper shank cutters
116/42 Collet spanner
116/52 $\frac{15}{16}$ inch A/F Open-ended spanner

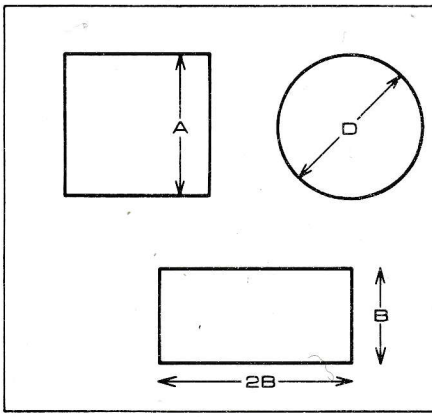
110/688 4 mm Collet
110/689 6 mm Collet
110/690 8 mm Collet
110/691 10 mm Collet
110/1010 Adapter for taper shank cutters
} Metric Machine

WORK CAPACITY

(Measurements with the pantograph style at the centre of the copyholder)

Throat depth	16¾ inches (425 mm)
Distance from spindle nose to worktable (spindle retracted):	
maximum	12½ inches (317 mm)
maximum using full throat depth	4 inches (100 mm)
minimum	½ inch (12 mm)
Horizontal distance from cutter point to worktable vertical slide	5⅝ inches (143 mm)

APPROXIMATE AREAS COVERED BY THE CUTTER

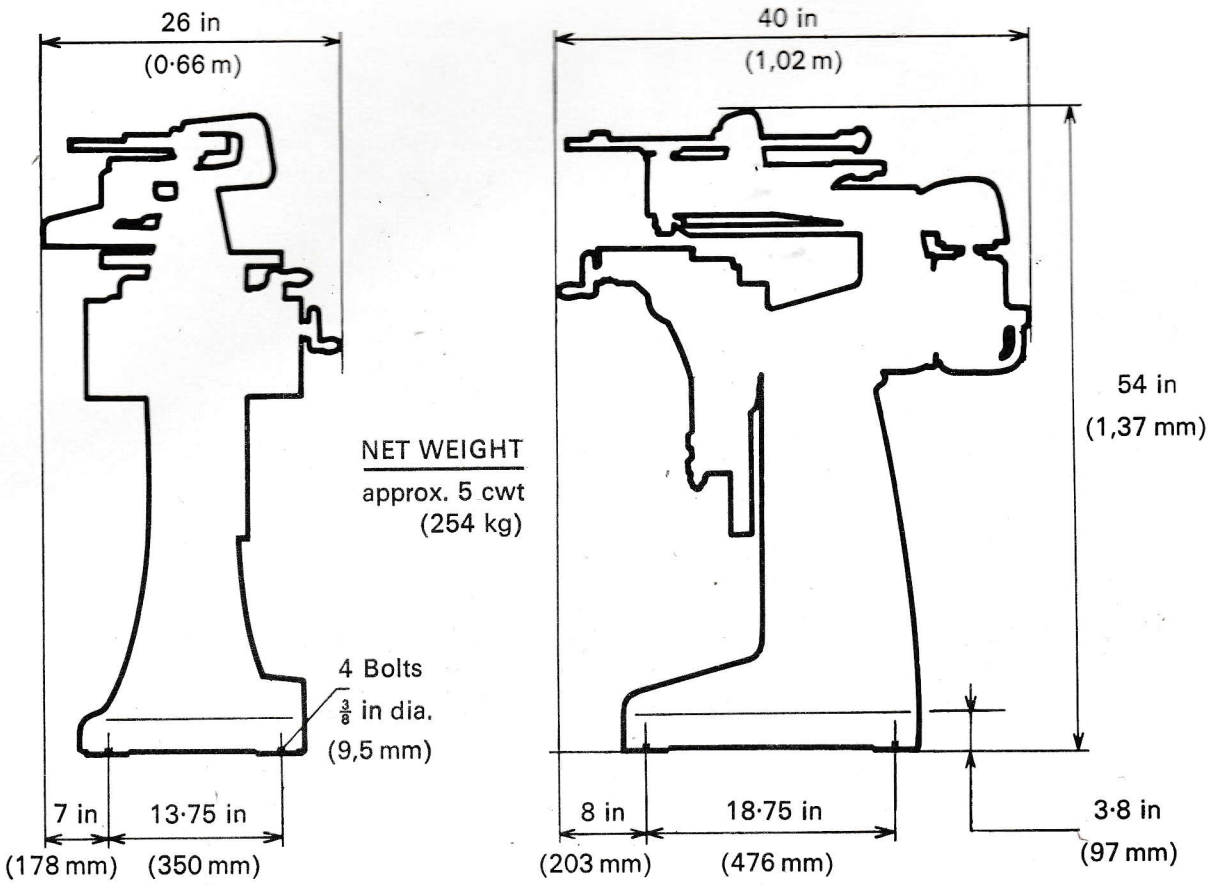


		1:1	2:1	3:1	4:1	6:1	8:1	12:1	16:1
A	in	6½	4⅜	3¼	2⅝	1⅞	1 7/16	1	¾
	mm	165	111	83	67	48	37	25	19
B	in	4½	3¾	2¾	2 3/16	1 9/16	1 3/16	⅞	⅝
	mm	115	95	70	55	40	30	22	16
D	in	6¾	4⅝	3½	2¾	2	1 9/16	1 3/32	13/16
	mm	171	118	89	70	51	40	28	21

PANTOGRAPH REDUCTIONS

The pantograph can be adjusted to give reductions from 1:1 to 30:1. Bar scales are graduated 1, 1·5, 2, 3, 4, 5, 6, 8, 10, 12, 14 and 16 for the most commonly used reductions. The settings for intermediate reductions from 1·1:1 to 30:1 can be obtained from the chart on page 31 or by means of the formulae on page 30.

OVERALL DIMENSIONS



WORK TABLE

	Motion	*Travel*
Size 15×8 inches (380×200 mm)	Vertical	12 inches (305 mm)
	Transverse	6 inches (152 mm)
4 tee-slots $\frac{3}{8}$×15 inches (9,5×380 mm) on $1\frac{7}{8}$ inch (47,6 mm) pitch	Longitudinal	14 inches (355 mm)

CUTTER SPEEDS (rev/min) 2730, 3580, 4680, 6140, 8010, 10 500 13 760 and 18 000

CUTTER TYPES TH taper shank engraving cutters
Parallel shank cutters up to $\frac{3}{8}$ inch or 10 mm diameter

CUTTER FEED Screw operated feed of $\frac{3}{8}$ inch (9,5 mm)

ELECTRICAL SUPPLY

Machines are supplied for operation on one of the following supplies:

Cycles/second	50	50	60	60
Phase	1	3	1	3
Voltage	230/250	380/440	110	220
Motor h.p.	$\frac{1}{6}$	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{1}{6}$

INSTALLATION

GENERAL

Ropes used for lifting should be placed only around the top part of the bow frame (with the pantograph, head and copyholder removed). On no account should ropes be put under the worktable slide rest or the drive motor. Make sure that no strain is placed on the bracket which carries the cutter frame linkage. Protect the paintwork with soft cloth.

It is essential that the worktable should be approximately horizontal and if the floor is not level it may be necessary to put packing under one or more corners of the machine.

Four holes in the base (see Fig. 1) allow for floor fixing either by foundation bolts or by Rawlplug fitting. Though the machine need not be fixed, the floor should be of solid construction and reasonably free from vibration.

Wherever possible the machine should be installed near a window so that the operator faces the light. If a bench light is provided, it should illuminate the work from behind and slightly above the cutter when viewed from the operating position. The base of such a light should be fitted to the machine frame at the side of the isolator.

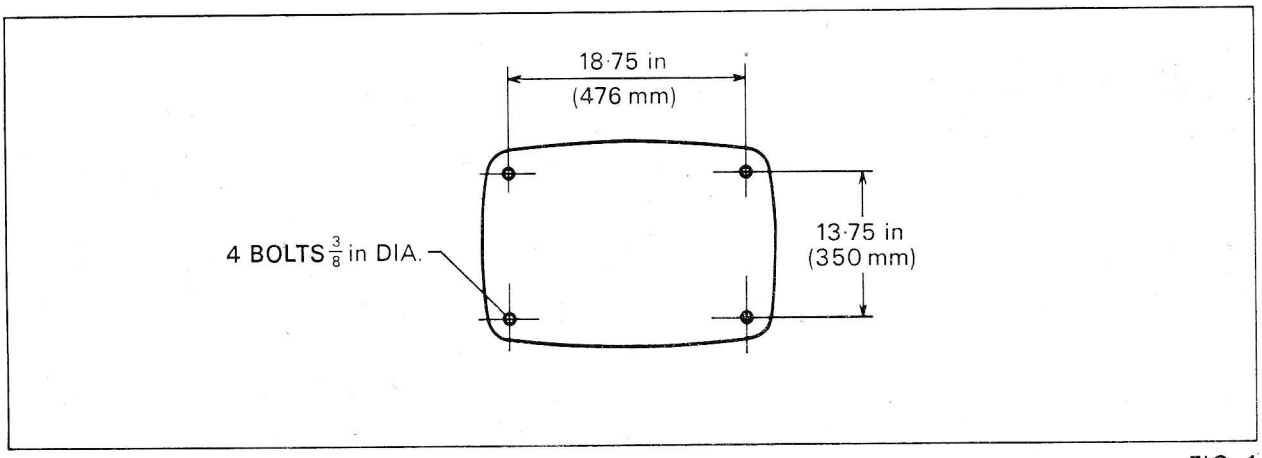


FIG. 1

ELECTRICAL CONNECTION

We strongly recommend that a competent electrician should connect the machine to the mains supply. Specific instructions are given and in all cases a direct connection should be made from the machine to a suitable earthing point, this connection can be made from the earthing screw on the isolator.

On machines wired for operation on three-phase electrical supply, check that the motor pulley rotates in a clockwise direction when viewed from above. This check must be made before the drive belts are fitted. If rotation is not clockwise, interchange any two of the three input connections.

50 c/s MAINS

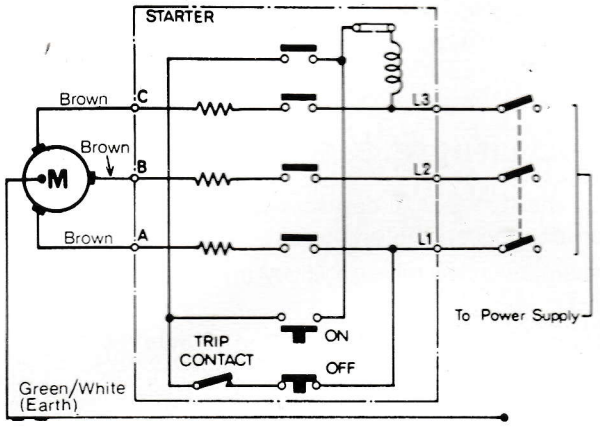
The electrical circuit consists of an isolator, push button starter (incorporating thermal overload protection and no-volt release) and electric motor. Wiring is complete from the isolator to the motor but connection of the isolator to the mains must be made as follows:

Set the isolator switch lever to "Off", take out the screw holding the isolator cover and open the cover. Carry out the wiring according to the appropriate diagram, Fig. 2.

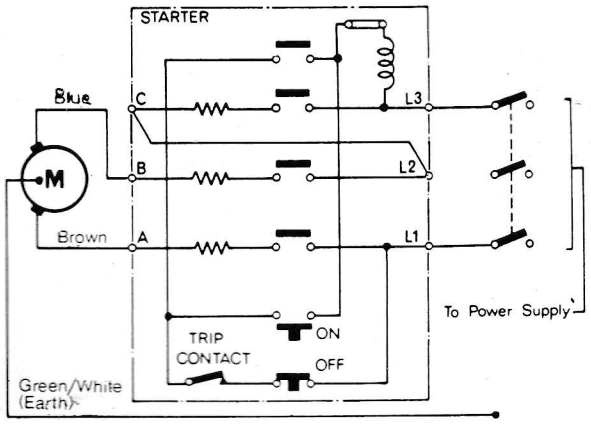
60 c/s MAINS

The electrical circuit consists of a push button starter (incorporating thermal overload protection and no-volt release) and electric motor. The motor is wired to the starter but connection of the starter to the mains must be made via an isolator of approved design. Remove the cover from the starter unit and make connections as shown in the appropriate diagram, Fig. 2.

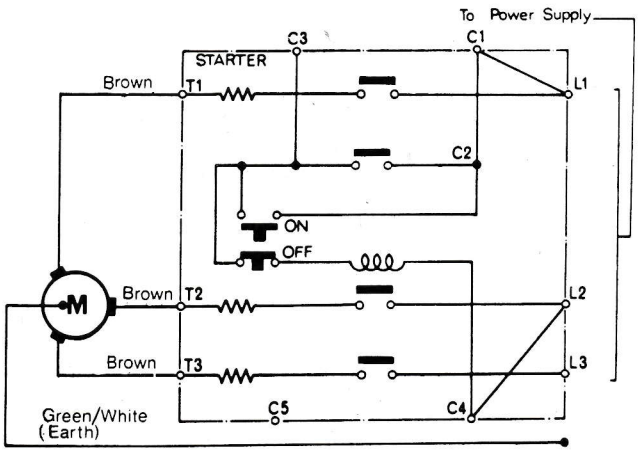
WIRING DIAGRAMS



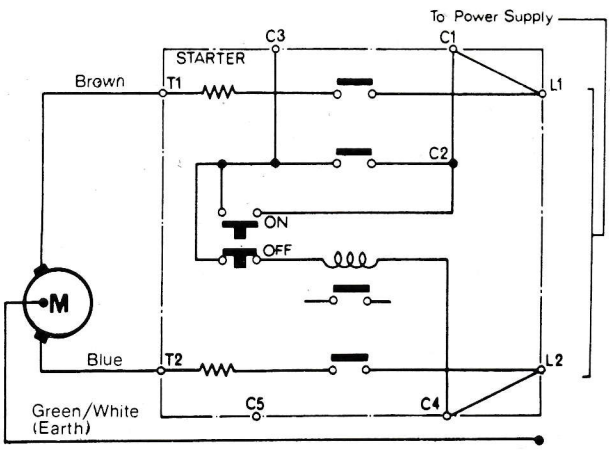
50 C/S THREE-PHASE



50 C/S SINGLE-PHASE



60 C/S THREE-PHASE



60 C/S SINGLE-PHASE

FIG. 2

ASSEMBLY

GENERAL

All the necessary tools for assembling the machine are part of the standard equipment.

Transit grease which has lubricating properties, is applied to all bright metal parts and excess amounts should be wiped off before erection.

ASSEMBLING THE CUTTER FRAME AND LINK (FIG. 3)

Secure the cutter frame link (A) to the pivot post (B) by the two 2 B.A. cap screws which are left in the pivot post for transit. The link is provided with a vee for location on the pivot post.

To achieve correct setting, slacken both screws by approximately two turns to allow the assembly to settle under its own weight. Fully tighten both screws.

NOTE: Do not lift the cutter frame (C) and link assembly before finally tightening the screws.

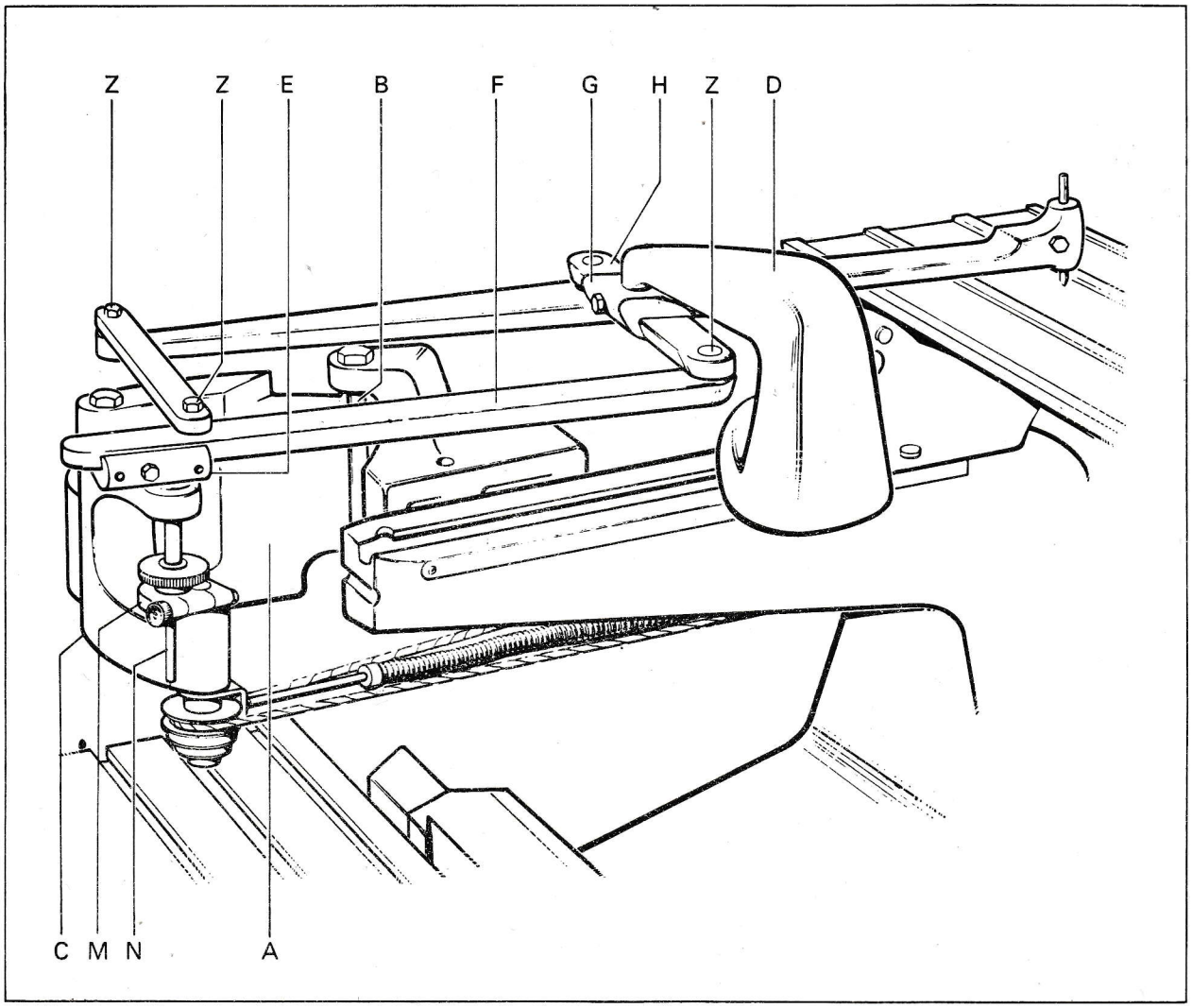


FIG. 3

FITTING THE PANTOGRAPH HEAD (FIG. 3)

The head dog, which clamps the pantograph head (D) to the frame, has one straight and one bevelled edge and the frame is shaped internally to match.

Place the head (D) in position on the frame, inserting the head dog through the wider slot provided at one end of the machine surface and slide the head until the zero line on the head coincides with numeral 3 on the scale. Tighten the head clamp bolt using the $\frac{1}{2}$ inch spanner provided.

IMPORTANT: Do not overtighten the head clamp bolt.

ASSEMBLING THE PANTOGRAPH (FIG. 3)

Slacken the 0 B.A. hexagon head screw at the top of the cutter frame (C) and take out the slider body (E). Assemble the slider body to the pantograph bar (F), with the hexagon clamp screw on the same side as the bar graduations, and set the scalloped edge of the slider body coincident with the line marked 3 on the bar. Lightly clamp the slider body by the hexagon screw.

Reassemble the slider body (E) to the cutter frame (C) ensuring that the shoulder on the slider body boss engages the machined face of the cutter frame, and securely tighten the 0 B.A. hexagon head screw in the cutter frame (C).

Turn the slider body (G) so that the hexagon head clamp screw is towards the cutter frame, as shown, and slide the pantograph bar (H) into the slider body. Set the line marked 3 on the bar coincident with the bevelled (rear) edge of the slider body and clamp by the hexagon head screw.

The pantograph is now assembled and is set for operation at 3:1 reduction. (This particular reduction is arbitrary.)

Note that the nuts which will be seen on the two slider body bearings are for adjustment only when required, see maintenance, page 14.

CUTTER SPINDLE AND FEED ASSEMBLY

The elements of this assembly, shown in Fig. 4, comprise the feed screw spindle (D), the yoke (E) and the cutter spindle. The feed spindle and yoke are left in position in the cutter frame with the yoke clamped to a transit post fitted in place of the cutter spindle which is packed separately.

Slacken the 0 B.A. hexagon head screws of the yoke and spindle sleeve and remove the transit post which can be discarded. Insert the cutter spindle from underneath into the spindle sleeve and yoke, clamping the yoke to the spindle quill (below the cap) as shown. Operate the feed wheel and tighten the hexagon head screw of the spindle sleeve until the spindle moves easily, but not too freely, up and down in its sleeve. The spindle should not feed down under its own weight when the machine is switched on.

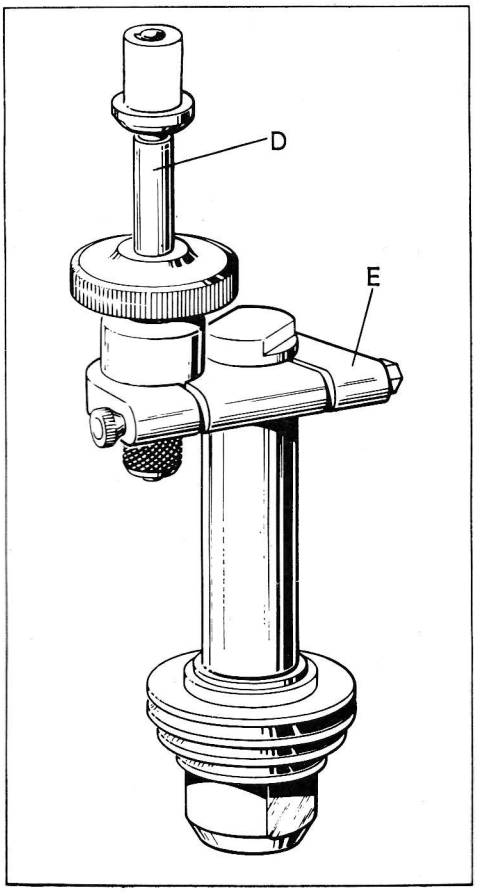


FIG. 4

REAR DRIVE ARM STAY ROD UNIT (FIG. 5)

On the back of the machine frame, above the drive motor, there is a double-ended cone spindle which is the pivot for the rear drive arm (A).

Unpack the rear drive arm and clean out any dust from the bronze cone bearings. Apply a little grease to the cones and unscrew the bearings, leaving the threads engaged, until the bearings can be slipped over the coned spindle. Fully tighten the lower cone bearing (B) and adjust the upper cone bearing (C) until all shake is removed but the unit still swings freely. Finally, tighten the locknut on the upper cone bearing.

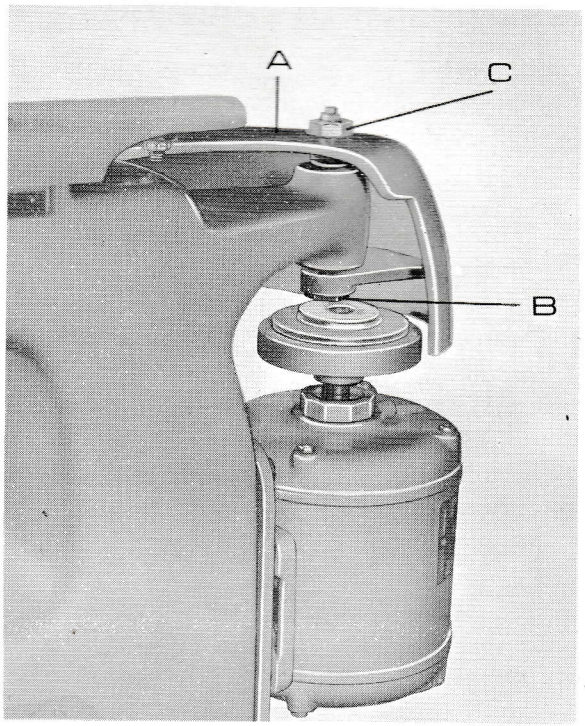


FIG. 5

FITTING THE DRIVE BELTS

The endless cotton spindle drive belt must be fitted before the motor belt. Engage the forked end of the stay rod in the groove at the bottom of the cutter frame and fit the spindle drive belt to the countershaft pulley and the spindle; the belt will hold the stay rod in position.

The belt label (Fig. 6) which is attached to the head of the machine shows how the belts are fitted to obtain a given spindle speed. The spindle drive belt must always be fitted in the top steps of the countershaft pulley.

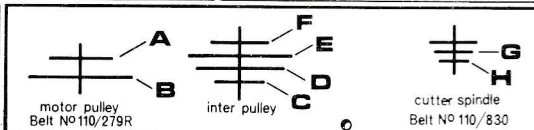
To tension the spindle belt, slacken the screw in the spring retaining collar on the stay rod, slide back the collar to increase the spring tension and re-tighten the collar screw.

An elastic belt is provided for the drive from the motor to the countershaft pulley, requiring no adjustment. Fit the belt to the appropriate steps of the pulleys according to the spindle speed required.

Made in England by
RANK PRECISION INDUSTRIES
Leeds

Engraving Machine
TYPE D No

PHASE
VOLTS
CYCLES
MAX-AMP
HP



Cutter Spindle Speeds RPM							
2730	3580	4680	6140	8010	10500	13760	18000
A	A	A	A	B	B	B	B
D	D	D	D	C	C	C	C
F	F	E	E	F	F	E	E
G	H	G	H	G	H	G	H

FIG. 6

FITTING A COPYHOLDER

All copyholders for Model 'D' Engraving Machines are interchangeable and are provided with two stop faces on the underside to engage one or the other of the two stop screws on the machine head. These stop screws are pre-set so that the copyholder grooves are either parallel to or square to the worktable tee-slots when a stop face is in engagement.

The copyholder bolt is normally captive and is prevented from falling out by the screwdriver-slotted screw on the underside of the copyholder seating boss.

The copyholder can be best assembled with the head slid back to approximately 1:1 position, when sufficient room is available under the bolt to allow manipulation by the fingers. Place the copyholder in position on the seating face provided, with the two stop faces on the same side as the pre-set stop screws, and engage the copyholder bolt in the copyholder. Finally, tighten the bolt securely using the $\frac{1}{2}$-inch spanner provided and return the head to the required position.

OPERATING INSTRUCTIONS

OPERATING POSITION

The operator should be seated on a stool approximately 2 feet (0,6 m) high with his feet on the foot mat.

When the operator is correctly seated, all controls are conveniently positioned and he can comfortably move the pantograph style over the whole area.

CUTTER SPEEDS

The belt label, Fig. 6, which is attached to the head of the machine shows how the belts are fitted to obtain a given speed. A table of suggested cutter speeds and coolants for the engraving of various materials is given on page 13. See also notes in the appendix on the engraving of non-metallic materials. Speeds are calculated for lower two grooves only.

CUTTER SPINDLE (TYPE 'L')

This is the standard spindle for the Model 'D' engraving machine, it will give long service without attention and will be found useful for numerous other workshop operations.

The spindle accepts parallel shank cutters of sizes $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, $\frac{1}{4}$ inch and $\frac{3}{8}$ inch (metric sizes: 4 mm, 6 mm, 8 mm and 10 mm) using equivalent size collets. The collet (B) and the cutter are retained in the spindle nose (A) by the screw cap (C).

A special adaptor (TH code 110/674) is provided with the machine enabling standard taper shank cutters to be used with the spindle. A wrench can be used on the flats provided just beneath the pulley to prevent the spindle rotating whilst the screw cap is being tightened.

A Type 'K' Ball Bearing Spindle which is an optional accessory and accepts TH taper shank cutters only is shown on page 20.

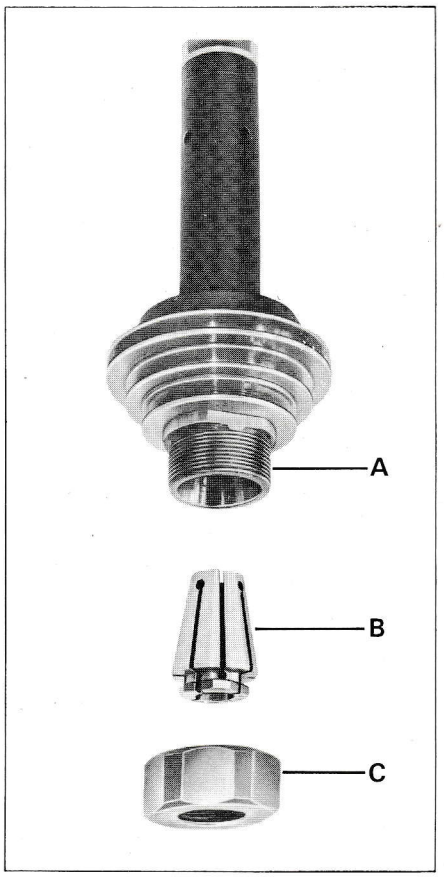


FIG. 7

SETTING THE PANTOGRAPH

Slacken the slider body clamp screws and the head clamp bolt and adjust it to bring the index edges of the slider bodies adjacent to the lines indicating the required reduction, and the head zero line coincident with the appropriate graduation on the scale. Clamp in position.

Always use the eyeglass provided when setting the pantograph slider bodies; incorrect setting will cause distortion in the engraving. With the pantograph correctly set, the whole of the width of the graduation line should just be visible alongside the slider body.

To avoid confusion, only the reductions commonly used are marked on the bars. The settings for intermediate reductions can be obtained from the schedule of intermediate reductions, page 31 or by means of the formulae on page 30.

SETTING THE PANTOGRAPH STYLE

Slacken the style clamp screw. Hold down the style with its point in the copy groove, raise the end of the style arm not more than $\frac{1}{32}$ inch (0,8 mm) and re-clamp. The slight "set" now given to the pantograph will help to keep the style in the copy. The style arm will spring sufficiently to permit the style to be moved from one character to another.

HOLDING THE WORK

The worktable incorporates four tee-slots 15 inches long × $\frac{3}{8}$ inch wide (380 × 9,5 mm). Table dogs and bolts are provided for clamping workpieces or work-holding fixtures. When setting up for repetition work, all worktable movements should be locked to prevent accidental disturbance; the slide locking screws are shown at B in Fig. 9. Table fences can be built up around the workpiece for easy location of subsequent parts. The table fence provided is designed for clamping in the tee-slots and provides a face parallel with the longitudinal movement of the worktable.

Workholding fixtures available as accessories to the machine are described in the accessories section.

USING THE SPINDLE FEED

The depth of cut is best set by using feeler gauges inserted between the spindle yoke M (Fig. 3) and the top of the feed stop N. The stop is in the form of a ground pin held in a split sleeve on the cutter frame.

Fully retract the spindle and set the stop pin so that the spindle feed can be operated through a distance exceeding the desired depth of cut. Insert a feeler gauge of the required thickness (i.e., corresponding to the required depth of cut) between the stop pin and the spindle yoke and feed down the spindle until the feeler gauge is just held.

Raise the work table until the surface of the work just touches the cutter point; retract the spindle and remove the feeler gauge. Commence engraving, feeding the spindle down to the stop for each character.

When engraving characters on undulating surfaces the feed stop should not be used, instead the depth of cut should be regulated to maintain an even width of line.

CONTROLLING THE CUTTER

When any revolving cutter is fed into its work at the beginning of a line as at 'A' in Fig. 8, it has no lateral displacement, but as soon as it is traversed it tends to move to one side of its proper course. With the engraving cutter rotating clockwise, this tendency is to the left of its line of advance.

Whether the displacement is perceptible or not depends upon the heaviness of cut and the degree of freedom in the machine joints.

In cutting the outlines of raised characters it is generally desirable to take both roughing and finishing cuts traversing anti-clockwise externally and clockwise internally round each character.

To prevent overcutting, roughing cuts should be taken using a style or roller that is slightly oversize in proportion to the cutter, thus leaving a slight surplus of material for removal at the finishing cut using the final size of roller together with the correct proportionate cutter diameter. See also "Engraving from sunk or raised copy" page 26.

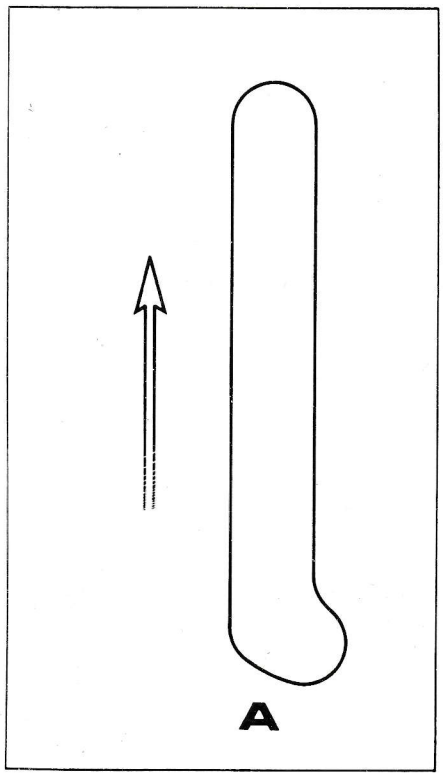


FIG. 8

CUTTER GRINDING

The bench model cutter grinder for use with all engraving machines is illustrated on page 24. Full instructions for grinding cutters are supplied with the cutter grinder.

Codes — 110/883-S inches
110/948-S metric

CUTTER SPEEDS

A similar table is printed on the instruction card issued with the Model 'G' Cutter Grinder. The tables agree in all details except certain cutter speeds, those quoted on the instruction card being appropriate to the speed range of the Model 'K' Machine. Where differences occur, the nearest speed applicable to Model 'D' is given.

Material	*Material of cutter*	*Width of cut up to*	*Clearance angle*	*Rev/Min of cutter*	*Recommended coolant (see note below)*
Free Cutting Brass	Talyspeed	0·10 in 2,5 mm	32°	18,000	none
Sheet Zinc	Talyspeed	0·10 in 2,5 mm	40°	18,000	A
Tough 'Cartridge' Brass	Talyspeed	0·01 in 0,25 mm 0·10 in 2,5 mm	40° 40°	18,000 13,760	D or E
Aluminium	Talyspeed	0·10 in 2,5 mm	40°	18,000	A
Mild Steel	Talyspeed or Speedicut	0·01 in 0,25 mm 0·10 in 2,5 mm	40° 40°	18,000 13,760	D or E
Copper	Talyspeed	0·01 in 0,25 mm 0·10 in 2,5 mm	40° 40°	18,000 13,760	E or A
Staybrite Steel	Talyspeed or Speedicut	0·05 in 1,25 mm 0·10 in 2,5 mm	40° 40°	18,000 13,760	C
Tool and die steel	Talyspeed or Speedicut	0·05 in 1,25 mm 0·10 in 2,5 mm	32° 32°	8010 4680	D or E
Vybak	Speedicut	0·06 in 1,5 mm	40°	4680	A or B*
Cobex	Speedicut	0·06 in 1,5 mm	40°	4680	A or B*
Perspex	Talyspeed	0·10 in 2,5 mm	40°	18,000	none
Formica engraving material	Carbide	0·06 in 1,5 mm	32°	18,000	none

For general letter engraving 'Trutaper' Axiflat cutters code 110/464, 110/862 or 110/863 are recommended. For letter punches and die work 'Trutaper' Rigiflat cutters code 110/163 should be used.

Recommended Coolant

A: Paraffin.

B: Pure turpentine.

C: Pure turpentine and powdered camphor mixed in proportions 4 fluid ounces turpentine to 1 ounce camphor.

D: Frapol No. 77 (sold by Edgar Vaughan Ltd., Legge Street, Birmingham) diluted with turpentine (3 to 1).

E: Ragosine R.T.D. compound (obtainable from Rocol Ltd., Rocol House, Swillington, Leeds, England) mixed with paraffin in equal proportions.

The cutter speeds quoted were found to be acceptable at the time of investigation, but it should be appreciated that variation in speeds may be necessary depending on material characteristics.

*Rigid thermoplastics such as Vybak and Cobex are vulnerable to overheating during engraving, resulting in softening and poor definition of characters. As an alternative to liquid coolant a cool air blast directed around the point of the cutter will be found helpful both in the removal of swarf and the prevention of overheating.

MAINTENANCE

The following maintenance operations can be carried out by the machine operator.

LUBRICATION (FIGS. 3 & 9)

Daily: Apply a little oil to the feed nut and screw and also smear oil around the spindle quill. With a hexagon wrench key give a half turn to the four grease screws, top and bottom, in the pivots of the cutter frame and link.

Note: When these four screws can no longer be turned they should be removed and the holes packed with grease, the screws then being replaced.

Weekly: Lubricate all slideways, lead screws and gears with medium grade machine oil, working the oil into the lead screw nuts and gears. Apply a little oil to all the needle bearing joints of the pantograph (beneath the screws (Z) Fig. 3) and the frame screw bearing (A) Fig. 9. A thin film of oil applied to the machined sections of the pantograph bars will prevent corrosion and give easy setting of reductions. Lubricate at the three grease nipples (G) Fig. 9 and the nipple in the rear drive arm upper cone bearing; the cone spindle has an axial hole to permit grease to pass to the lower cone as well as to the upper cone. The countershaft pulley is fitted with ball bearings packed with grease and requires no attention.

ADJUSTMENT OF SLIDES (FIG. 9)

After considerable use, the slides which carry the worktable may need adjusting. This is a simple matter.

Vertical Slide: Lightly tighten the four screws (K) to take up any slack but leave the slide still reasonably free to be moved by the handwheel.

Table Slide: Lightly adjust the three screws (M), under the table, as above.

Frame Slide: This slide does not need adjusting, the gib strip screws are used only for locking purposes.

CORRECTING SLIDE SCREW END PLAY (FIG. 9)

Table and Frame: The lead screws are held in place by split screwed bushes (D), each provided with two holes, one on either side of the slit. Each lead screw has a corresponding hole.

Adjust by inserting a $\frac{1}{8}$ inch (3 mm) diameter tommy bar through one of the bush holes and into the lead screw, thus locking the two parts together and allowing them to be turned as one by means of the handwheel.

Be sure to choose the appropriate hole so that, as the lead screw is turned, the bush tends to close.

The lead screw and bush can be completely removed by inserting the tommy bar into the hole to the right (left U.S.A.) of the slit, as viewed from the handwheel, and rotating the lead screw anti-clockwise (clockwise U.S.A.) When replacing the lead screw, or adjusting the split bush to take out end play, the other hole in the bush must be used.

Vertical Slide: To remove end play in the lead screw, slacken the nut (L), adjust the nut (N) just to take out the play and then re-tighten the nut (L).

Backlash between the gears can be taken out by slackening the three screws (S) and, with a spanner, slightly rotating the eccentric bush (E). Retighten the three screws (S).

ADJUSTING THE PANTOGRAPH

If, after long use, any play becomes apparent in the bearings of the slider bodies, this can be taken up by the nuts which will be seen on the two slider body bearings and the similar nut where the pantograph bar (H) Fig. 3, joins the style arm.

Important: Any adjustment must be carefully controlled and taken up very gradually otherwise damage to the bearings may result.

The procedure for removing the pantograph is the reverse of the erection instructions given on pages 8 and 9.

Note that each slider body is paired with its pantograph bar on assembly and, where the customer is in possession of more than one Model 'D' machine, each pantograph must be kept with its own machine.

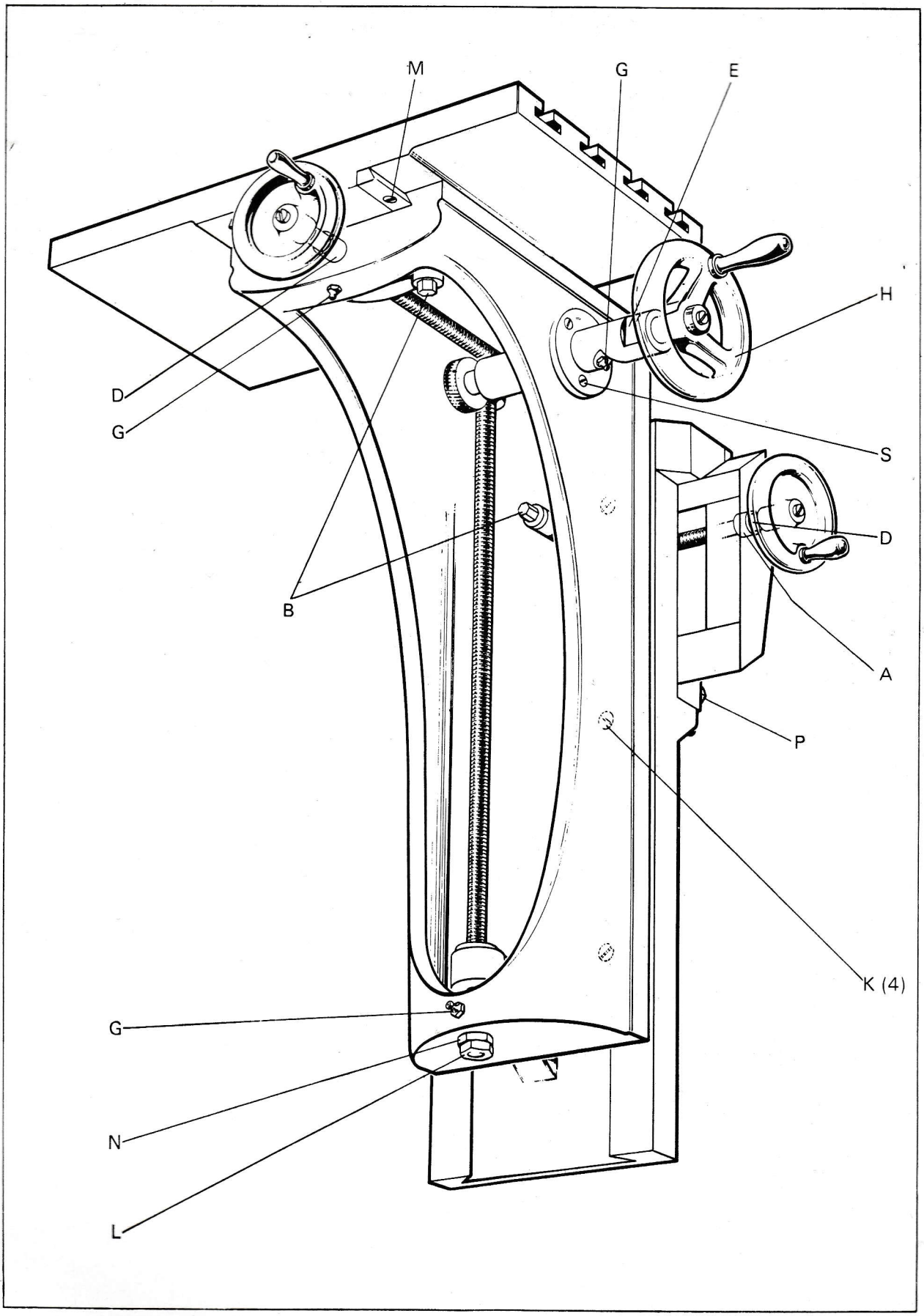


FIG. 9

SERVICING

The Model 'D' Engraving Machine is designed to have a long and trouble-free life. Very little servicing is needed.

We strongly recommend that any service operations which may be required should be carried out only by TH or their agents. If this is inconvenient the work should be carried out by a competent engineer who should use parts obtained from TH and work to their instructions.

In the case of cutter spindle failure, damage to the cutter frame and link or the pantograph, the unit should be returned to TH or a local agent. Rebuilding these units involves specialised equipment.

SERVICE ITEMS AND SPARES

Name	*Quantity per machine*	*Code No.*		
Cutter frame link centre	4	02404		
Cutter frame link pivot post	2	02406		
Yoke feed to spindle	1	039		
Nut for yoke	1	074		
Stud for yoke	1	075		
Feed assembly	1	K045		
Feed nut only	1	016		
Head dog	1	66/127		
Saddle slide screw and nut	1	K03068	K03072	
Bracket slide screw and nut (vertical)	1	K03059	K03060	
Table slide screw and nut	1	K03062	Inches K03066	Metric
Nut only (horizontal slide screws)	2	66/336	66/730	
Nut only (vertical slide screw)	1	028	03058	
0 B.A. hex. head screw (feed stop sleeve)	1	20/44		
0 B.A. hex. head screw (stay rod collar)	1	20/45		
0 B.A. hex. head screw (spindle sleeve, slider body bearing sleeve, yoke copyholder stops)	5	20/46		
Bearing (countershaft pulley)	2	640/108		

For other items see list on page 4

CODE NUMBERS OF ACCESSORIES

Machine vice		110/17
Style and rollers		110/66
Dividing head		110/79–S
Lorograph etching unit		110/1090
Rapid feed		110/1013
Single 'Javelin' etcher		110/184–S
Extension table		110/216–S
Presser foot		110/1015
Graduated handwheels	inches	110/1014
	metric	110/1033
Forming attachment		110/233
Extension bars (1 pair)		110/240
Type 'K' spindle		110/894
Circular table		110/944–S
Model 'G' cutter grinder	inches	110/883–S
Diamond marking tool	metre	110/948–S
These are described on pages 17 to 24.		110/904

ACCESSORIES

FORMING ATTACHMENT (FIGS. 10 & 11)

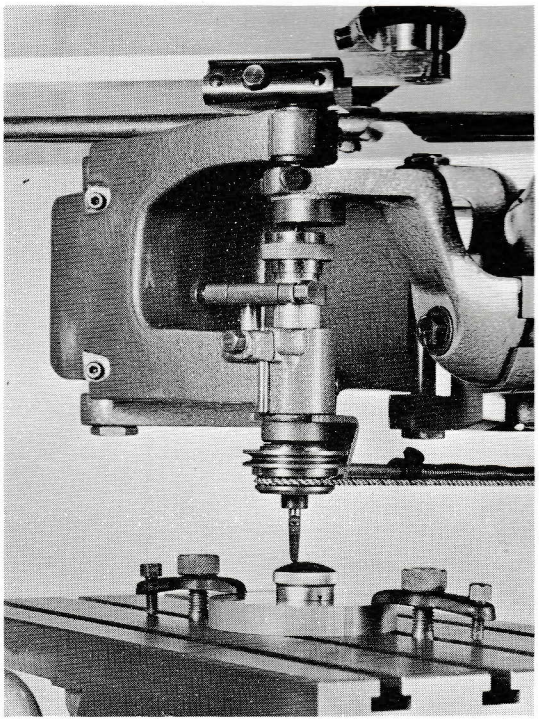


FIG. 10

The Forming Attachment, Fig. 10 is used for engraving on curved or slightly contoured work and comprises a bracket which carries a former (a counterpart of the form of the work), forming feed assembly, spring box and stylus.

The former, which will generally be of spherical or cylindrical form, is mounted above the spindle and the spindle is spring-urged upwards so that a stylus on the feed assembly maintains contact with the former and, as the spindle is moved under pantograph control, causes the spindle to rise and fall following the contour of the former and the work surface.

The forming movement of the spindle is $\frac{3}{8}$ inch (9,5 mm) which provides for working over a maximum depth of contour of the same dimension, and the maximum area that can be covered is that of a circle $1\frac{1}{2}$ inches (38 mm) in diameter.

The depth of cut is controlled by a scaled feed ring. graduated in 0·001 inch steps, read off against an index line provided on the feed nut. The maximum amount of cutter feed available is 0·15 inch (3,8 mm), but this may vary slightly according to the overall thickness of the former.

The cutter frame is fixed to the forming bracket, by the setting bar provided, during setting up so that the former, the copy and the work can be correctly positioned relative to each other. A truly ground pointed cutter will provide a means of indicating that the work is well centred beneath the spindle and former. Setting up procedure is as follows:

Remove the drive belt from the spindle pulley (the belt may conveniently be placed round the cutter frame whilst setting up proceeds), spindle, yoke and feed mechanism.

Fit the forming bracket to the tenon-slotted seating face on the machine frame and secure by the $\frac{3}{8}$ inch hexagon head bolt and washer provided.

Set the pantograph at the required reduction, fit the setting bar (small diameter uppermost) in the spindle sleeve and adjust the position of the cutter frame until the spigot on the bar will enter the $\frac{1}{2}$ inch diameter hole in the forming bracket. Clamp the setting bar in position by means of the 0 B.A. hexagon head screws in the cutter frame and forming bracket.

Place the copy in the copyholder, setting the copy central to the style. If the copy cannot be set truly central about the style then slacken the head clamp bolt and adjust the position of the head to bring the copyholder and copy to the required position. Re-tighten the head clamp bolt, clamp the copy in position and set the pantograph style on the exact centre of the copy. The copy is now correctly positioned relative to the spigot hole in the forming bracket.

Remove the setting bar. Unscrew the end cap from the spindle quill and screw in the feed assembly (B) Fig. 11 without the feed ring (A) which locates on a key pin in the top of the feed screw. Replace the spindle in the spindle sleeve and assemble the yoke (F) spring (E) and spring box (G), as shown. Tighten the yoke to prevent the spindle quill revolving, fit the feed ring (A) to the feed screw, pass the tommy bar provided through the hole in the feed ring and into the hole in the feed nut and lock the feed assembly to the spindle quill.

Adjust the angular position of the spindle until the zero line on the feed assembly is facing the operating position, and check that the spindle moves freely up and down in its jacket, with and against the pressure of the spring (E). If necessary, adjust the position of the screw (D) in the cutter frame to obtain maximum movement. Re-fit the spindle drive belt.

Fit the former to the bracket and check that the stylus maintains contact with the former as the spindle is moved over the whole area. Operate the feed screw and check that the spindle feeds down smoothly; adjust the feed screw friction if necessary, by means of the screw (C), the feed assembly being removed from the spindle quill whilst the adjustment is made.

Finally, with the pantograph style located in the centre of the copy, set the work central beneath the spindle using a truly-ground pointed cutter as a means of indication. If repetition work is intended, fit table fences round the work so that subsequent workpieces can be positioned without repeating the setting procedure. Lock the longitudinal and transverse table movements.

In operation, the former should be kept lubricated with medium grade machine oil.

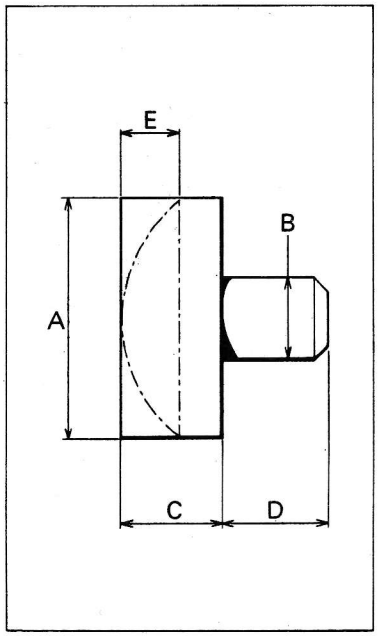


FIG. 12

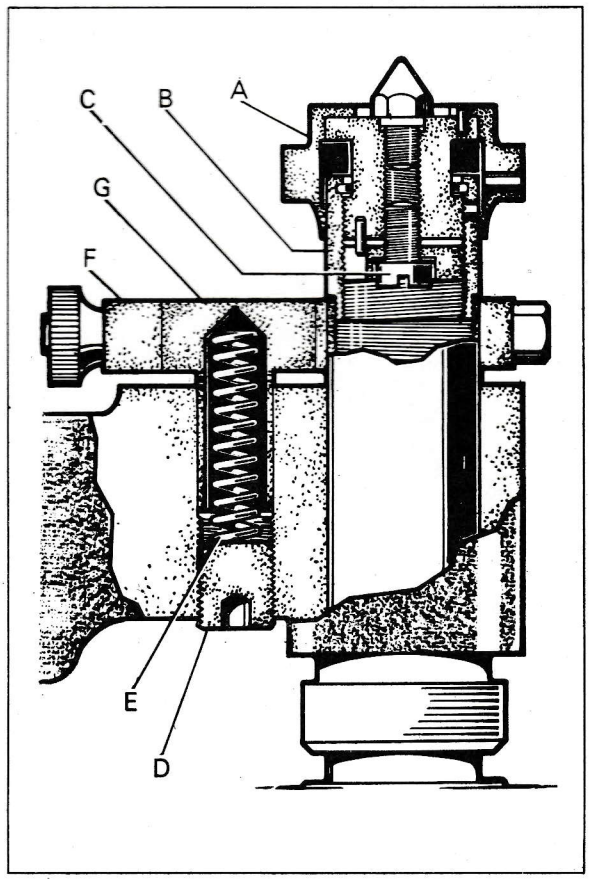


FIG. 11

FORMERS

Formers should preferably be of hardened steel and should have a $\frac{1}{2}$ inch (12,7 mm) diameter $\times \frac{9}{16}$ inch (14 mm) long shank machined on them to fit the milling and forming bracket. The shank must be concentric with the contour on the former face.

NOTE: Convex formers should be made to the radius of the work minus the radius of the stylus, and concave formers made larger by the radius of the stylus.

Prepared former blanks of mild steel, 3 inches (76 mm) in diameter and $\frac{1}{2}$ inch (12,7 mm) thick, can be obtained from RTH. For those wishing to make their own blanks, the essential dimensions given in Fig. 12 are:

A. 3·0 in (76,2 mm) maximum diameter.
B. 0·499 in (12,7 mm) diameter.
C. 0·5 in (12,7 mm) maximum.
D. 0·56 in (14,3 mm).
E. 0·38 in (9,5 mm) maximum contour.

The method of cutting the contour on the blank will depend on the nature of the contour. Simple concave and convex surfaces can be turned, but more complex forms will have to be cut on some type of three-dimensional copying machine. TH will make formers for users not equipped to carry out such operations, provided full information regarding the contour is supplied.

DIVIDING HEAD

The dividing head is used to hold and rotate circular work such as discs, cones and cylinders to present successive portions to the cutter.

The two long edges of the base are ground square to each other so that it can be set square to fences on the machine table. When the faceplate is set horizontally up against the end stop, it is accurately parallel to the base and its surface is 4 inches (102 mm) above the bottom surface of the base. When it is set vertically against the vertical stop, it is accurately square to the base and the axis of the $\frac{3}{4}$ inch (19 mm) bore is $3\frac{1}{2}$ inches (89 mm) above the bottom surface of the base.

The 6 inch (152 mm) diameter faceplate is rotated by hand and is locked at the desired setting by the handle (A). The canting movement is also hand operated and is locked by the socket grub screw (B). Both these movements are accurately calibrated in degrees and index marks (C) on the fixed parts are provided.

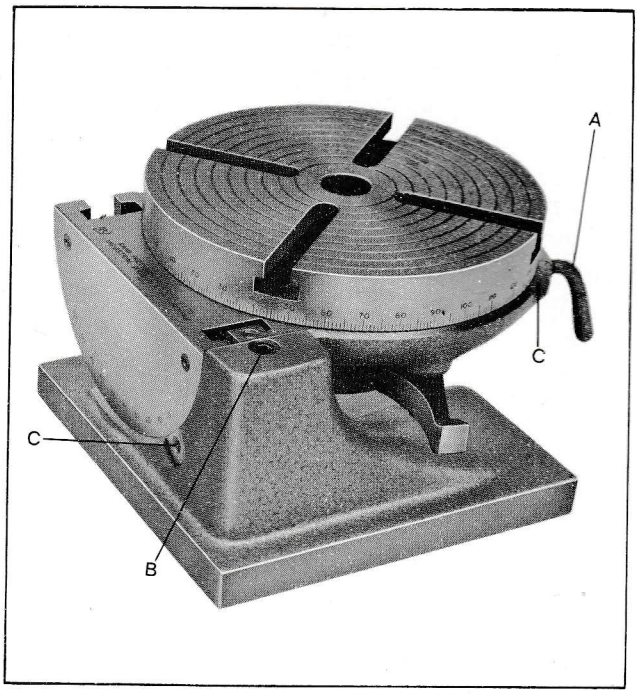


FIG. 18

For centring the workpiece, a series of concentric circles is cut in the faceplate; the central hole, $\frac{3}{4}$ inch (19 mm) diameter, is accurately bored and can be used to locate accurately the workholding fixtures. The faceplate is tee-slotted to receive the normal worktable fittings.

DIVIDERS

For rapidly indexing the faceplate of the dividing head, dividers (A) can be attached to the lower end of the faceplate shaft. A divider is a disc bearing notches round its periphery – normally 12, 72, 90, 120, 180 or 360 equally spaces notches. Notches are correct to pitch within $\pm 1\frac{1}{2}$ minutes of arc.

To fit a divider, slacken the clamp screw (B) and remove the collar (C). Fit the divider to the shaft, pushing it fully home and replace the collar, ensuring that the two pins in its face engage the corresponding holes of the divider; then tighten the clamp screw.

When using the dividing head with a divider fitted, the locking handle should be left free, so that the table rotates freely and is held in each position by the action of the spring-loaded pawl (D). Dividers can be fitted for anti-clockwise rotation of the table with the pawl positioned as shown, or for clockwise rotation with the pawl reversed. With the pawl swung upwards so that the tooth is as far as possible from the divider, it can be pulled off its shaft; it can then be reversed and refitted to allow for opposite rotation of the divider.

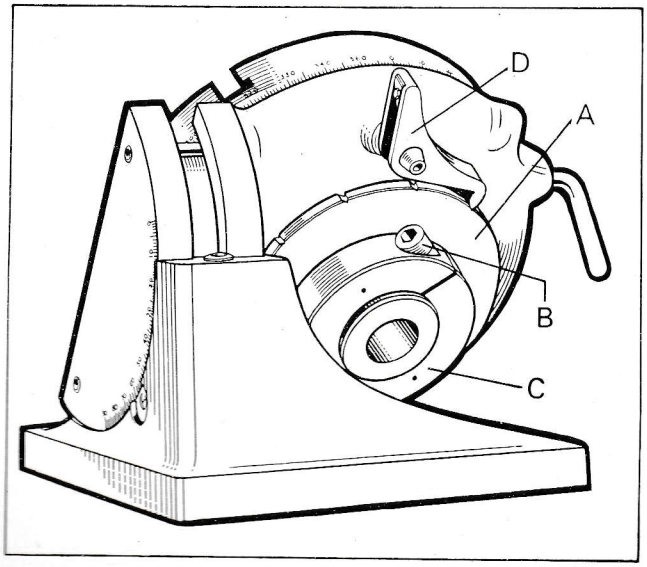


FIG. 19

When using this attachment for engraving around circular, conical or cylindrical work, the workpiece should be rotated step by step and the copy characters should be brought in turn to one position on the copyholder. This position should generally be above the centre hole or zero of the copyholder.

MACHINE VICE

This is a small vice that can be clamped with standard table fittings directly on to the machine worktable, dividing head or the circular table. The long edges of the base are parallel to each other and square to the jaws. Tenon slots cut in the base also permit the jaws to be set square or parallel to the worktable tee-slots, either by the fitting of tenons or locating the sides of the slots against the table fence.

The hardened steel jaws are 2 inches (50 mm) wide, $1\frac{1}{2}$ inches (38 mm) deep and open to 2 inches (50 mm). A loose vee-jaw is supplied for holding cylindrical work.

TYPE 'K' BALL BEARING SPINDLE

This spindle accepts TH taper shank cutters only.

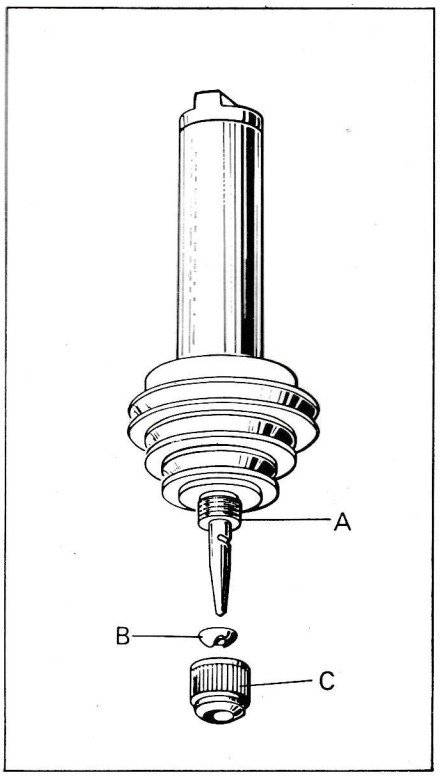


FIG. 15

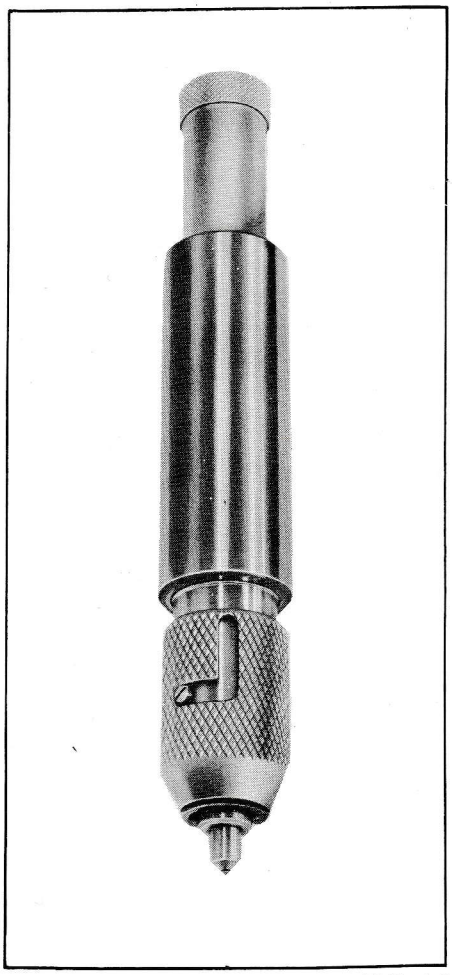


FIG. 16

DIAMOND MARKING TOOL

Regular or irregular shaped articles in a wide variety of hard and soft materials can be marked with this tool. It incorporates a non-rotating diamond bit housed at the end of a spring-loaded plunger unit fitted to the engraving machine in place of the cutter spindle. Cutting pressure can be varied, enabling an even depth of cut to be maintained. The diamond is cut to an included angle of 120°.

PRESSER FOOT

The Presser Foot is used to maintain an even depth of cut over slightly undulating surfaces or on thin materials which are apt to buckle. The foot (A) engages the work surface and should only be used for work which requires a finishing process after engraving. In use, the foot (A) is attached to the spindle by means of a special yoke (B) and adjusted for height above the cutter point to give the required depth of cut. Hand pressure applied downwards to the yoke (B), controls engraving.

The setting up procedure is as follows:

Remove the spindle drive belt, spindle, yoke and feed mechanism (the spindle belt can be placed around the cutter frame to retain the stay rod in position). Replace the spindle, and clamp in mid-position in its sleeve. Insert the compression spring into the cutter frame; locate the plunger (C) on the underside of the yoke (B) over the spring and the yoke over the spindle quill and clamp the yoke in position just below the spindle end cap (D). If not already fitted, fit the keyed bush and foot to the yoke and clamp in position with the forked end of the foot centred around the cutter point. Using adjusting nuts (E) set the height of the foot relative to the cutter point and lock both nuts firmly against the bush. Finally, refit the spindle drive belt and release the spindle sleeve clamp screw enough to permit the spindle to slide smoothly in its sleeve with and against the pressure of the spring.

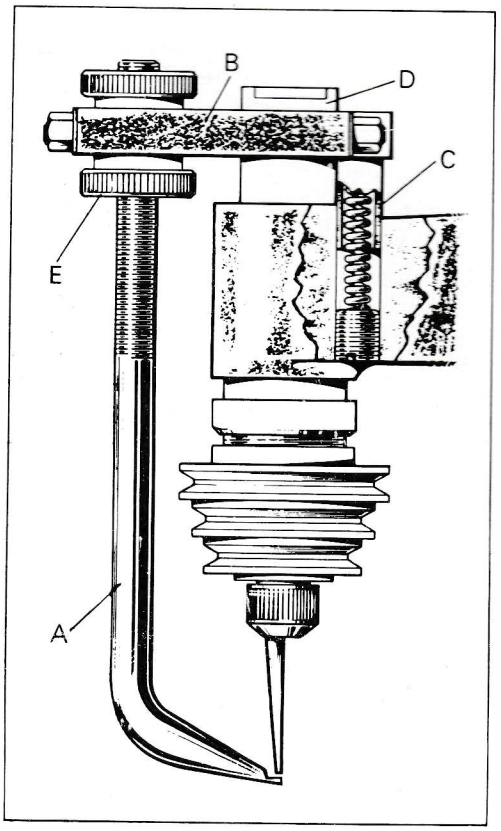


FIG. 13

CIRCULAR TABLE

The circular table comprises a 12 inch (305 mm) diameter circular rotating table, with a $\frac{3}{4}$ inch (19 mm) centre hole for accurately locating the work or work-holding fixtures on the rotation axis. A series of concentric circles at 1 inch (25,4 mm) spacing is provided for centring the work, and tee-slots position the normal worktable fittings.

Slots in the base enable the circular table to be clamped to the machine table.

The rotary table is accurately graduated in degrees and can be rotated either by hand or by the worm; it is clamped by the locking nuts (A). The zero indicator (B) is locked in position by a knurled screw and can be adjusted through 5 degrees. The worm is operated by the handwheel which carries a scale ring (C) accurately graduated in minutes, one complete rotation of the handwheel corresponding to a rotational movement of the table of 2 degrees. The scale ring is held by friction, this enables the scale to be set in any position against the zero.

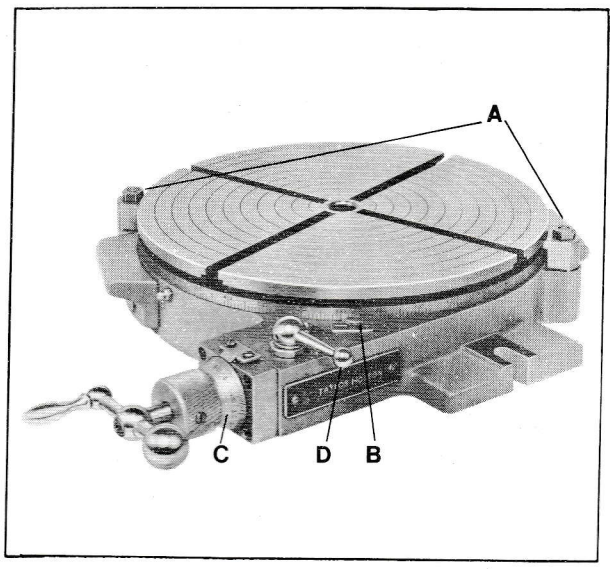


FIG. 20

To disengage the worm to allow free movement of the table, rotate the worm engagement lever (D) in an anti-clockwise direction. To re-engage the worm, rotate the lever in clockwise direction, until it locks. If between disengaging and re-engaging the worm, the table has been rotated, slight rotation of the handwheel may be necessary to bring the worm into mesh. It will then lock home.

EXTENSION TABLE AND BARS

The extension table measures $14\frac{1}{2} \times 18$ inches (368 × 457 mm) and is fitted on top of the machine worktable. It will hold plates up to 18 inches (457 mm) wide and of indefinite length.

The extension bars also shown are a useful addition to the table and provide support for plates up to 30 inches (762 mm) wide. Plates up to 33 inches (838 mm) wide can be engraved at all parts by reversal.

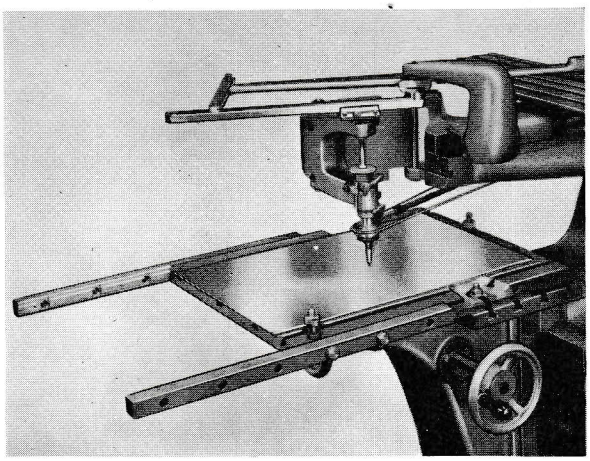


FIG. 21

ETCHERS

Two forms of electric etching equipment are made for use with TH Engraving Machines. Each set of equipment consists of a transformer, suitably encased, certain accessories and a writing unit. Writing units fit in place of the cutter spindle and are moved under pantograph control in the normal manner.

The single 'Javelin' etcher, Fig. 22, will mark most smooth metal surfaces, is quick, clean and safe and no prior or after treatment of the surface is necessary. Etching is effected by rapid electric sparking at the point of a vibrating electrode (the 'Javelin'). The 'Javelin' etcher is fitted in place of the cutter spindle and clamped in the spindle jacket. The spindle drive belt and stay rod are removed and swung clear of the cutter frame. The feed mechanism may be left in position but is not used with the etcher, the work being brought to the 'Javelin' by means of the worktable vertical feed. Full operating instructions are issued with the equipment.

The lorograph etcher, which is used freehand, will etch most materials having a high electrical resistance (e.g. iron and steel). Etching is effected by the localised heating and softening of the metal; it is therefore not suitable for work on which there is no finishing process. It is ideal for marking tools, gauges, etc.

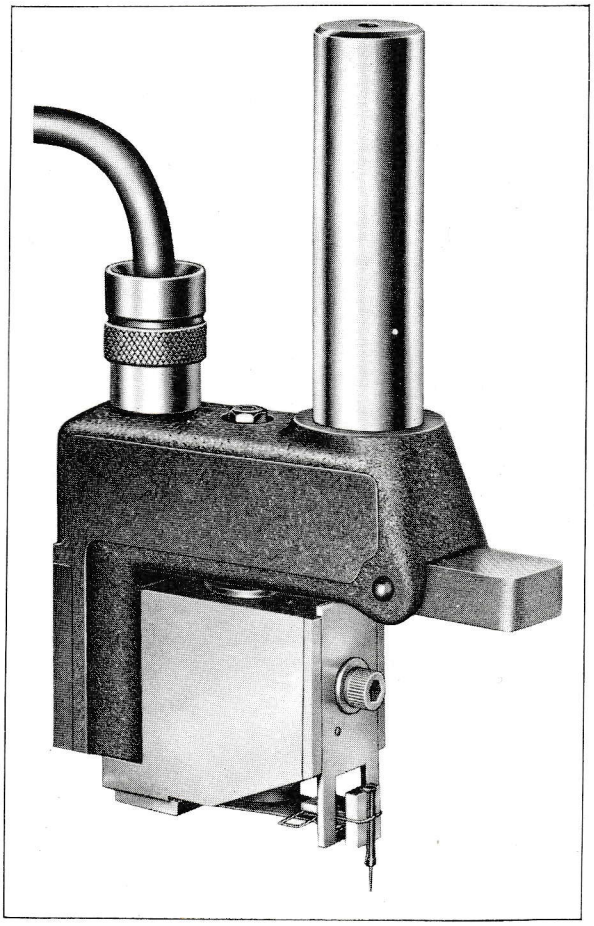


FIG. 22

COPY AND COPYHOLDERS

A wide range of copy in many styles is available from stock and special copy can be made on request. Copy is made in three standard sizes, the height of a capital character in each case being $\frac{3}{4}$ inch (19 mm), $1\frac{1}{2}$ inches (38 mm) or 3 inches (76 mm).

For repetition work it is normally advisable to have a set copy (i.e. all engraved on one plate) rather than to set up the copy each time. TH have facilities for making such copy, also copy bearing trade marks and other designs.

Both tee-slot and circular model copyholders are available. The choice depends on size and type of copy.

MODEL 'G' CUTTER GRINDER

The Model 'G' cutter grinder, for use with all TH engraving machines, produces accurately the correct cutting edge, clearance angle and cutter shape for most types of engraving.

The setting gauge and stop cams for the cutter holder provided with the cutter grinder ensure precise grinding of the clearance angle whilst the in-feed screw, graduated in increments of 0·002 inch (0,05 mm), permits specified cutter sizes to be readily achieved.

Sturdily built as a free standing bench model, the cutter grinder enables the cutter to be frequently reground to maintain the cutting edge, without disturbing the engraving machine settings.

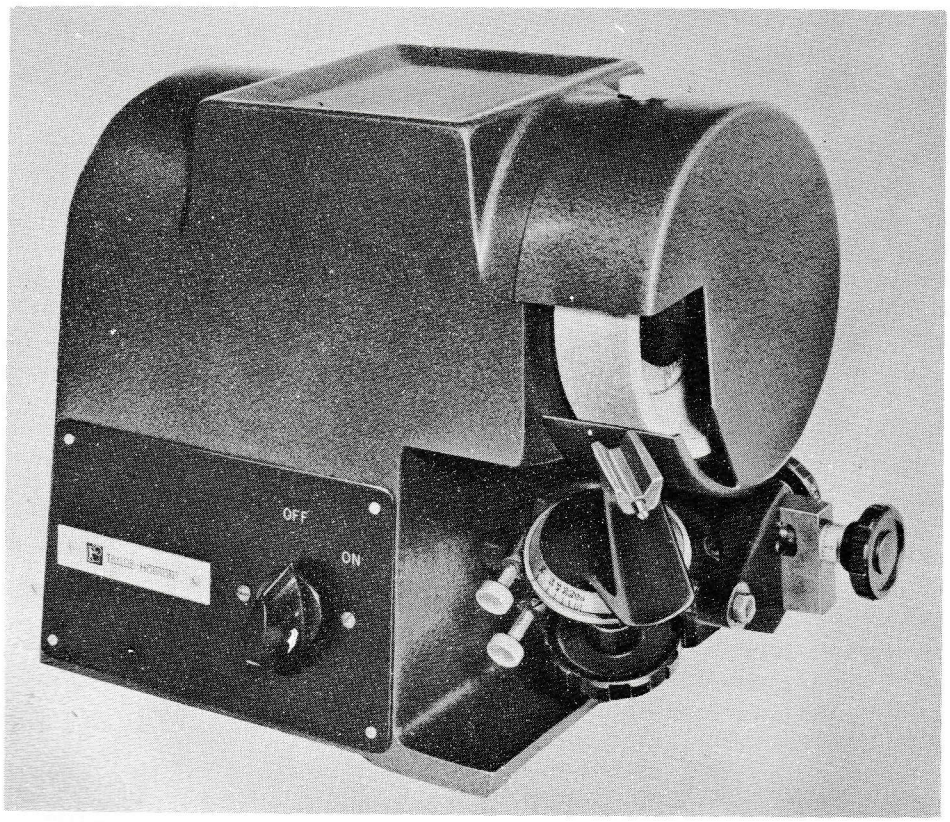


FIG. 23

APPENDIX

This appendix contains information on the art of engraving and is a summary of the more important items rather than a comprehensive authoritative account of the whole technique.

LAYOUT AND SPACING OF COPY

Engraving cannot look pleasing unless the copy is correctly spaced.

Normally, when arranging standard copy characters in the copyholder, it is only necessary to have the blanks, on which the characters are cut, in contact to achieve good spacing. These blanks have been designed so that when in contact they give the best spacing with average combinations of characters, though certain combinations will not look right (e.g. in the word 'HILT' the 'HIL' appear crowded, and the 'L' and 'T' widely spaced). To adjust such spacings, spacers of various widths are supplied with all sets of standard copy.

When arranging a set copy (i.e. when the whole copy is cut on one plate) the copy should be designed to have a balanced appearance.

SIZE OF COPY AND WORK

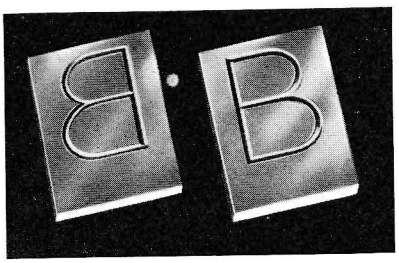
The same size of engraving may be obtained from copy of different sizes by varying the reductions. For example, characters $\frac{1}{4}$ inch (6,3 mm) high may be engraved from $\frac{3}{4}$ inch (19 mm) copy with a 3:1 reduction, from $1\frac{1}{2}$ inch (38 mm) copy with a 6:1 reduction or from 3 inch (76 mm) copy with a 12:1 reduction.

When using large copy and a fairly large reduction ratio, there is greater leverage on the pantograph. This gives better cutter control, the copy is less subject to wear and, due to the large reduction, any small amount of wear will not be apparent on the work. Small copy is an advantage when the complete copy is very long and has to be engraved at one setting.

LENGTHY INSCRIPTIONS

If the complete copy requires more characters than the copyholder can hold at one setting, the complete copy should be laid out on a table with correct spacing and measured, the central character will serve as the key for setting-up. The pantograph reduction can be calculated if the area to be engraved is known, or vice versa. Place half the copy, including the key character, in the copyholder and arrange the work so that its centre line is under the cutter when the pantograph style is centred in the key character (which should be at one end of the copyholder). Clamp the work, and then engrave the key character followed by all the others in the copyholder. Remove this copy and replace it with the other half, retaining the key character at the other end of the copyholder. Adjust the worktable so that the cutter coincides with the engraved key character when the pantograph style is in the corresponding copy character.

ENGRAVING FROM LINE COPY



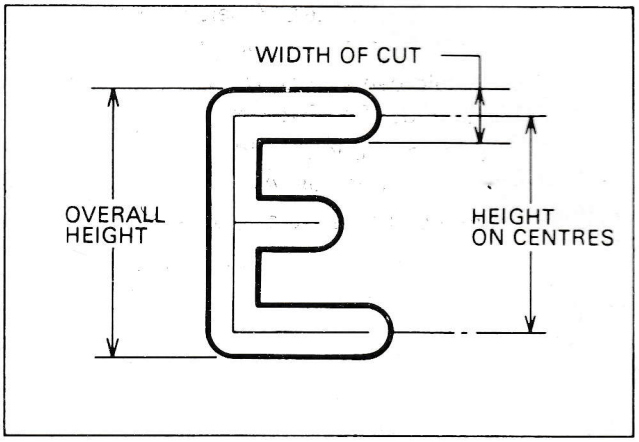
Line copy takes the form of a simple vee-groove which matches the 90 degree conical point of the pantograph style. Line copy height is measured from centre of line to centre of line. The copy height divided by the pantograph reduction will be the height (on centres) of the engraved character. The overall height of the engraved character will be determined by the face width of the engraving:

$$\text{Overall height of engraved character} = \frac{\text{height of copy}}{\text{reduction}} + \text{width of cut}$$

The width of cut can be varied within certain limits, either by varying the depth of cut when using a pointed cutter, or by varying the diameter of a parallel-sided cutter. If too wide a cut is taken, the engraved characters will be disproportionate and in extreme cases the small lands (as in 'a' and 'e') may be completely cut away.

Generally, the width of cut should be one-seventh of the height (on centres) of the engraved character – one eighth of the overall height. Where the height (on centres) is specified or, alternatively, where the size of copy on reduction to be used is specified, the width of cut is determined by dividing the height (on centres)

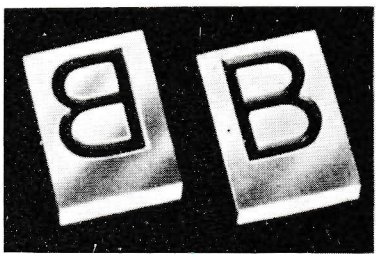
by seven. For example, to produce the capital E shown with a height on centres of 0·75 inch (19 mm) the width of cut will be 0·75÷7=0·11 inch (19÷7=2,7 mm). The overall height of the character will therefore be 0·75+0·11=0·86 inch (19+2,7=21,7 mm).



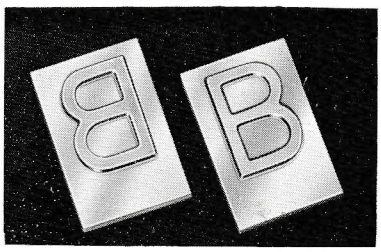
To produce engraved characters of a given overall height, the width of cut is determined by dividing the overall height by eight. The width of cut is then subtracted from the overall height to give the height (on centres) after which the required pantograph reduction can be calculated by dividing the copy height by overall height of 1 inch (25,4 mm) the width of cut will be 1÷8=0·125 inch (25,4÷8=3,2 mm) and the height (on centres) will be 1 – 0·125=0·875 inch (25,4 – 3,2=22,2 mm).

When measuring the height of line copy choose a character with straight vertical and horizontal lines such as 'E'. As with printer's type, those characters having a curved top or bottom, or both, are made slightly large in order to give a balanced appearance. Characters having a double curve (C, G, O, Q, S & 6, 8, 9, 0) are made larger by one-fiftieth of the height of capital E, whilst those having a single curve (J, U, 2, 3, 5) are made larger by one-hundredth of the height of capital E.

ENGRAVING FROM SUNK AND RAISED COPY, USING STYLE ROLLERS



SUNK COPY



RAISED COPY

SUNK COPY can have varying widths of line, such as may be required for Roman or Old English Script.

RAISED COPY can have its width of line or face varied to produce counterparts of sunk copy, Roman, Old English Script etc.

Surplus metal should be cleared from around each raised copy character but there must be enough metal left on which to engrave the next letter, so it is important to use a set copy consisting of all the characters mounted on one piece of metal, in correct relationship to one another.

In order that engraving shall faithfully reproduce the copy the following relationship must be satisfied:

Diameter of style or roller = Diameter of cutter × pantograph reduction.

Thus with 10:1 reduction and a 0·50 inch (12,7 mm) diameter roller, the cutter must be 0·05 inch (1,27 mm) diameter.

This relationship applies to cylindrical cutters and also to conical cutters if the diameter is measured at the work surface when the depth of cut is correct. If the engraving is in a moulding die the cutter diameter at the bottom of the cut must be proportionate to the roller diameter, as it is this part which will be the surface of the finished product.

When rollers are used, roughing cuts should be made using the largest roller that will fit in the general shape of the copy, and with the proportionate cutter diameter. Gradually reduce the size of the roller together with that of the cutter, until the finishing cuts are taken using a roller of such diameter that it will move in and out of all the copy details.

ENGRAVING ON NON-METALLIC MATERIALS

PLASTICS AND LAMINATES. Thermoplastics and rigid laminates can be satisfactorily engraved using high speed or carbide cutters. A selection of some of the more common materials in these groups, together with information for obtaining best results, is given in the table of cutter speeds on page 13.

MARBLE. Marble can be engraved satisfactorily, using Speedicut steel cutters well lubricated with water and running at about 5,000 rev/min for $\frac{1}{4}$ inch (6,3 mm) letters. Cutter clearance should be 40°.

WOOD. Cutters for wood should have the cutting edge angles made acute. This can be done by grinding the flats past the cutter axis. A high speed is desirable for wood.

GLASS. Diamond cutters are available but these are only suitable for 'scratching' the surface of the glass.

SET COPY

When any inscription is to be engraved repeatedly, for example a firm's name or trade mark, the copy should be engraved on one plate as set copy.

TH have special facilities for making set copy to customers' requirements.

Well-designed set copy saves time and gives a finish and uniformity to work which are impossible with loose characters.

Set copy is sometimes used together with loose characters. For example, inscription plates for electric motors, machine tools, may have to be engraved with progressive serial numbers, in addition to a repeated inscription. In such cases a set copy carries the repeated matter and is provided with slots in which the serial numbers can be built up with standard copy figures.

Where inscriptions are too large to be engraved at one setting, the set copy may be in two or more parts. The copy and the workholders may be provided with register marks so that at each re-setting the copy and work will be located in the correct relative positions.

Where expense does not justify this method the set copy may be made to overlap so that after a change of copy the work may be placed correctly by setting the style in the overlapping part of the copy and setting the engraved portion of the work correspondingly under the cutter.

Set copy too large for standard copyholders may be adapted by mounting it on standard bevelled strip. Alternatively it may be held on the No. O tee-slot copyholder which measures 16 inches × 9 inches (406 mm × 228 mm).

For circular set copy see page 28.

BUILT-UP SET COPY

Copy may sometimes be made by using standard copy characters stuck down on a foundation of wood or stiff card (double-sided, pressure-sensitive adhesive tape is ideal for this purpose). This method will also be found useful when arranging copy to engrave permanent set copy form.

TEMPORARY COPY

Temporary copy in sunk, raised or line style can be very conveniently made from transparent cellulose acetate sheet* about $\frac{1}{32}$ inch (0,8 mm) thick. It is cheap to make and with care can be used about 30 to 100 times.

The copy is made directly from a drawing – an enlarged one if necessary – by placing the transparent sheet over it and tracing the diagram with a steel scriber; a straight edge and french curves may be used as guides. A cut 0·02 inch (0,5 mm) deep is quite sufficient to guide the style.

Line copy may be cut with a standard hand graver which can be obtained from small-tool suppliers.

Copy for sunk or relief engraving may be made as above by scribing the lines deeply and breaking the sheet along the lines. The point of a knife may be used instead of a scriber.

The copy should be tacked down to wood or stout card in order to protect it and hold it out flat. Use shoe tacks and place them close to the cut or the edge, as the case may be, so that there will be no tendency for the copy to lift and become distorted. Hammer the tacks in to about two-thirds of their length only, then cut off the heads with a pair of side cutting pliers. This avoids any tendency for the copy material to split. Finally hammer the tack stumps flush with the surface to avoid injury to the operator.

*A suitable material is 'Celastoid', a product of British Celanese Limited.

MATERIAL FOR COPY

Hard-rolled 'engravers' brass 0·064 inch (1,63 mm) thick has proved the best material for permanent copy. Copy of hardened steel has a longer life but the cost is considerably more and there are difficulties in hardening long set copy without warping.

CARE OF COPY

Copy should be kept free from grit and be lightly oiled from time to time. Line copy lasts a long time if the style is kept properly ground. Styles are cheaper than copy and should be reground regularly.

GRINDING THE PANTOGRAPH STYLE

This should normally be ground on a TH cutter grinder for, with the crutch correctly set, it is a simple matter to grind the style properly. A stop collar is provided for holding the style and locating it in the vee of the crutch. First grind an angle of 30 degrees and finally grind to 90 degrees, using the vee groove in the stop collar for checking the 90 degree angle. Remove the sharp point with an oilstone, leaving a flat of about 0·010 inch (0,254 mm).

CIRCULAR ENGRAVING

Classified as follows:

(1) Straight lines of characters along cylinders. This is done from standard or set copy held in standard copyholders. Depending on the cylinder diameter and the size of the engraved characters, it may be an advantage to use the forming attachment, page 17.

(2) Engraving around cylinders.
This may be carried out on the dividing head, page 21, used with the circular copyholder or with loose copy characters brought in turn to one position on the copyholder.

(3) Radial engraving, i.e. engraving curved lines of characters on flat surfaces.
Radial characters can be engraved using the dividing head and moving the copy step by step with the work. Set copy must be used for irregular characters (characters which are not radial) and should be used for radial characters when the amount of work to be done justifies the outlay. Curved copy for temporary use can be made by mounting separate copy characters on wood or stiff card.

When making large radial set copy, the dividing head can be adapted to hold large plates by mounting the tee-slot copyholder on it. To secure the copyholder to the dividing head, a $\frac{1}{2}$ inch B.S. Whitworth bolt, with a $3\frac{1}{2}$ inch (89 mm) long shank and a thread length of at least $\frac{3}{4}$ inch (19 mm) is required. A steel or brass washer should be fitted under the head of the bolt to prevent damage to the dividing head. The set copy can then be engraved from loose copy characters.

BALANCING THE CHARACTERS

When engraving curved lines of characters on a flat surface or on shallow cones, the 'balance' of the characters requires attention. If unbalanced characters like 'L' and 'J' are set with their centres radial to the centre of the curve, they will appear to be falling over when compared with symmetrical characters such as 'A' and 'O'. To correct this it is necessary to displace the unbalanced characters; in the case of the 'L' for example, its vertical line should be nearly radial.

FOR

REDUCTION FORMULAE

AND

TABLE OF INTERMEDIATE REDUCTIONS

SEE OVER

REDUCTION FORMULAE

INTERMEDIATE REDUCTIONS

The formulae below give the distances, in inches, at which the slider bodies must be set from the lines indicating 1:1 position.

Long Bar

$$12{\cdot}000 - \frac{12{\cdot}000}{R} \text{ inches}$$

Short Bar

$$3{\cdot}733 - \frac{7{\cdot}466}{R+1} \text{ inches}$$

R=Reduction required.

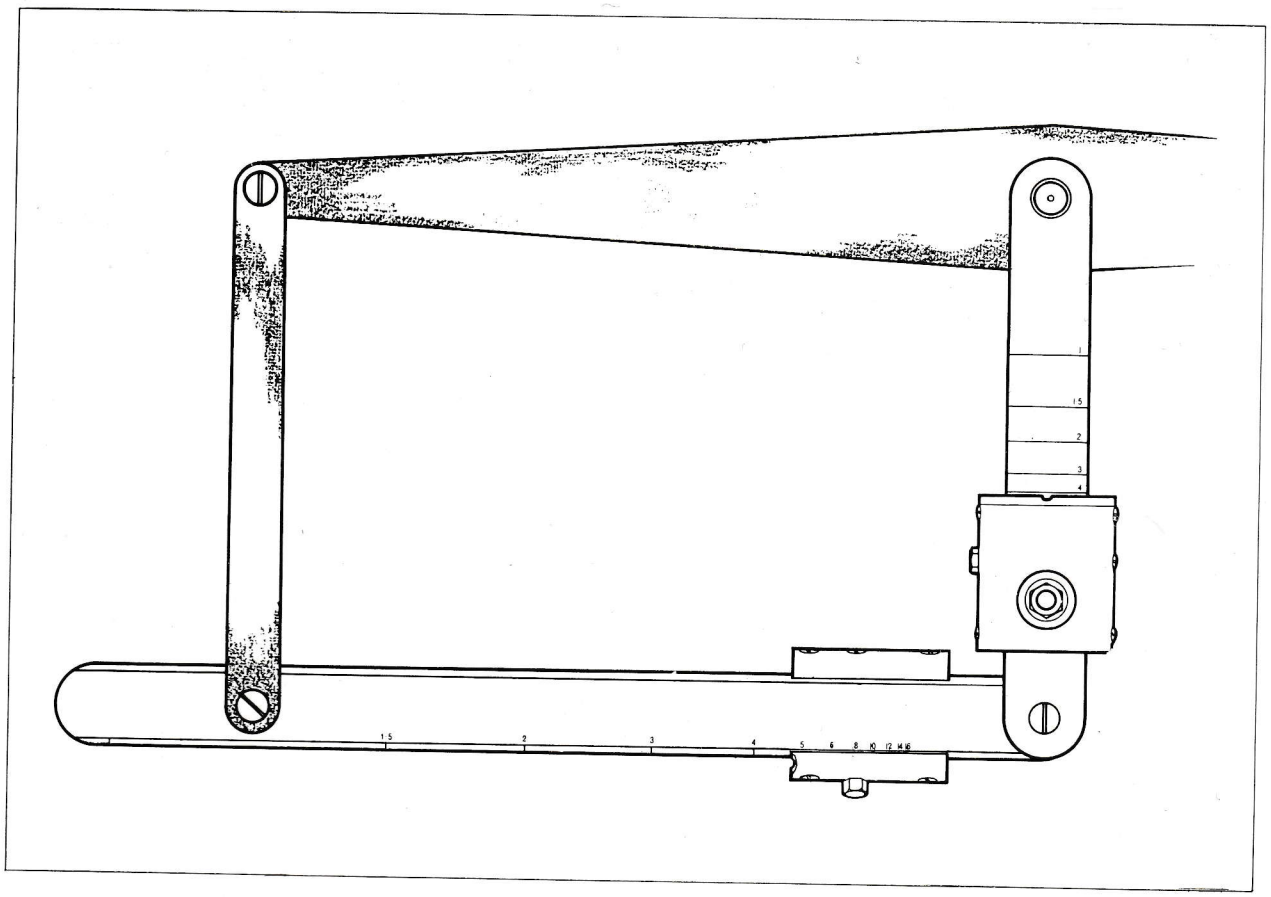


TABLE OF INTERMEDIATE REDUCTIONS
(INCHES)

The table below gives pantograph settings for reductions not marked on the bars. The figures given are the distances, *in inches*, at which the slider bodies must be set from the lines indicating 1:1 position. Settings can be made with sufficient accuracy using a magnifying glass and a rule graduated in fiftieths of an inch (both supplied as standard equipment).

Reduction	Long Bar	Short Bar	Reduction	Long Bar	Short Bar	Reduction	Long Bar	Short Bar
1:1·1	1·09	0·18	4·3	9·21	2·32	7·6	10·42	2·86
1·2	2·00	0·34	4·4	9·27	2·35	7·8	10·46	2·88
1·3	2·77	0·49	4·5	9·33	2·38	8·2	10·54	2·92
1·4	3·43	0·62	4·6	9·39	2·40	8·4	10·57	2·94
1·6	4·50	0·86	4·7	9·45	2·42	8·6	10·60	2·95
1·7	4·94	0·97	4·8	9·50	2·45	8·8	10·64	2·97
1·8	5·33	1·07	4·9	9·55	2·47	9·0	10·67	2·99
1·9	5·68	1·16	5·1	9·65	2·51	9·25	10·70	3·00
2·1	6·29	1·33	5·2	9·69	2·53	9·5	10·74	3·02
2·2	6·55	1·40	5·3	9·74	2·55	9·75	10·77	3·04
2·3	6·78	1·47	5·4	9·78	2·57	10·5	10·86	3·08
2·4	7·00	1·54	5·5	9·82	2·58	11·0	10·91	3·11
2·5	7·20	1·60	5·6	9·86	2·60	11·5	10·96	3·14
2·6	7·38	1·66	5·7	9·89	2·62	12·5	11·04	3·18
2·7	7·56	1·72	5·8	9·93	2·64	13·0	11·08	3·20
2·8	7·71	1·77	5·9	9·97	2·65	13·5	11·11	3·22
2·9	7·86	1·82	6·1	10·03	2·68	14·5	11·17	3·25
3·1	8·13	1·91	6·2	10·06	2·70	15·0	11·20	3·27
3·2	8·25	1·96	6·3	10·09	2·71	15·5	11·23	3·28
3·3	8·36	2·00	6·4	10·12	2·72	18·0	11·33	3·34
3·4	8·47	2·04	6·5	10·15	2·74	20·0	11·40	3·38
3·5	8·57	2·07	6·6	10·18	2·75	22·0	11·45	3·41
3·6	8·67	2·11	6·7	10·21	2·76	24·0	11·50	3·43
3·7	8·76	2·14	6·8	10·23	2·78	26·0	11·54	3·46
3·8	8·84	2·18	6·9	10·26	2·79	28·0	11·57	3·48
3·9	8·92	2·21	7·0	10·29	2·80	30·0	11·60	3·49
4·1	9·07	2·27	7·2	10·33	2·82			
4·2	9·14	2·29	7·4	10·38	2·84			

Example: Reduction required 4·5:1. Set the index edge of the slider body on the long bar 9·33 inches from the line marked 1 on the bar, and the slider body on the short bar 2·38 inches from the line 1 on its bar. Set the head zero line mid-way between 4 and 5 on the scale.

TABLE OF INTERMEDIATE REDUCTIONS
METRIC

The table below gives pantograph settings for reductions not marked on the bars. The figures given are the distances, in *mm*, at which the slider bodies must be set from the lines indicating 1:1 position. Settings can be made with sufficient accuracy using a magnifying glass and a metric rule (both supplied as standard equipment).

Reduction	Long Bar	Short Bar	Reduction	Long Bar	Short Bar	Reduction	Long Bar	Short Bar
1:1·1	27·69	4·57	4·3	233·93	58·93	7·6	264·67	72·64
1·2	50·80	8·64	4·4	235·46	59.69	7·8	265·68	73·15
1·3	70·36	12·45	4·5	236.98	60·45	8·2	267·72	74·17
1·4	87·12	15·75	4·6	238·51	60·96	8·4	268·48	74·68
1·6	114·30	21·84	4·7	240·03	61·47	8·6	269·24	74·93
1·7	125·48	24·64	4·8	241·30	62·23	8·8	270·26	75.44
1·8	135·38	27·18	4·9	242·57	62·74	9·0	271·02	75·95
1·9	144·27	29·46	5·1	245·11	63·75	9·25	271·78	76·20
2·1	159·77	33·78	5·2	246·13	64·26	9·5	272·80	76·71
2·2	166·37	35·56	5·3	247·40	64·77	9·75	273·56	77·22
2·3	172·21	37·34	5·4	248·41	65·28	10·5	275·84	78·23
2·4	177·80	39·12	5·5	249·43	65·53	11·0	277·11	78·99
2·5	182·88	40·64	5·6	250·44	66·04	11·5	278·38	79·76
2·6	187·45	42·16	5·7	251·21	66·55	12·5	280·42	80·77
2·7	192·02	43·69	5·8	252·22	67·06	13·0	281·43	81·28
2·8	195·83	44·96	5·9	253·24	67·31	13·5	282·19	81·79
2·9	199·64	46·23	6·1	254·76	68·07	14·5	283·72	82·55
3·1	206·50	48·51	6·2	255·52	68·58	15·0	284·48	83·06
3·2	209·55	49·78	6·3	256·29	68·83	15·5	285·24	83·31
3·3	212·34	50·80	6·4	257·05	69·09	18·0	287·78	84·84
3·4	215·14	51·82	6·5	257·81	69·60	20·0	289·56	85·85
3·5	217·68	52·58	6·6	258·57	69·85	22·0	290·83	86·61
3·6	220·22	53·59	6·7	259·33	70·10	24·0	292·10	87·12
3·7	222·50	54·36	6·8	259·84	70·61	26·0	293·12	87·88
3·8	224·54	55·37	6·9	260·60	70·87	28·0	293·88	88·39
3·9	226·57	56·13	7·0	261·37	71·12	30·0	294·64	88·65
4·1	230·38	57·66	7·2	262·38	71·63			
4·2	232·16	58·17	7·4	263·65	72·14			

Example: Reduction required 4·5:1. Set the index edge of the slider body on the long bar 236·98mm from the line marked 1 on the bar, and the slider body on the short bar 60·45mm from the line 1 on its bar. Set the head zero line mid-way between 4 and 5 on the scale.

REDUCTION FORMULAE

The formulae below give the distances, in mm, at which the slider bodies must be set from the lines indicating 1:1 position.

Long Bar: $304{\cdot}801 - \frac{304{\cdot}801}{R}$ mm

Short Bar: $94{\cdot}816 - \frac{189{\cdot}632}{R+1}$ mm

R = Reduction required

We reserve the right to make such alterations in design as we may consider necessary in the light of experience. For this reason, particulars and illustrations in this handbook may not conform in every detail to models in current production.

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